**Supplementary Table 1.** Current role of zooplankton in Southern Ocean ecosystems (based on information provided in taxonomic Sections Euphausiids (Family Euphausiidae), Copepods (Subclass Copepoda), Salps (Order Salpida), and Pteropods (Order Pteropoda)). Roles may vary across areas of the Southern Ocean, seasons, or with life history stages. See Figure 1 for locations and key to MEASO areas. See Supplementary Table 2 for environmental tolerances.

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| --- | --- | --- | --- |
| **Taxa** | **Key life history traits** | **Role in ecosystem structure and functioning** | **References\*** |
| A picture containing shape  Description automatically generated**Antarctic krill** | **Size range:** Largest adult size of all zooplankton species, max length >60 mm  **Larval stage duration:**  ~1 yr  **Life span:** Long lived, potentially >5 yrs  **Age at maturity:** Males 2 yrs, females  3 yrs | **Abundance/biomass:** Highest total biomass of all Southern Ocean zooplankton species. Production estimates: 342-536 Mt yr-1  **General distribution:** Circumpolar, predominantly south of the Antarctic Polar Front, significant concentrations observed in shelf areas of southwest Atlantic (Atlantic Sector), East Pacific Sector and Central Indian and East Indian Sectors. Horizontal distribution patchy at regional scales, with variability in their association with habitat features (incl. bathymetry, sea ice, and ocean currents). Ocean currents can connect regional populations over large scales (~1000 km). Information limited in some localities and seasons due to sparse sampling. Observed in epi-, meso- and bathypelagic zones (down to 3000 m), and in association with the seabed  **Habitat preference** Phenotypic plasticity and variations in life history strategies allow occupation of a range of habitats according to seasonal localised food availability. High levels of variability in its association with, and apparent dependence on, sea ice. Sea ice can be important for overwintering larval stages for food and refugia. Different size and life history stages depend on spatially restricted habitats favouring successful spawning and first winter larval survival. High density populations observed in both seasonal ice zones and ice-free areas. In ice covered waters, large part of population observed in upper water column, and at the ice-water interface. Forms highly aggregated dense swarms over mesoscales, particularly during summer, but degree of aggregation varies spatio-temporally. In some regions (e.g., Antarctic Peninsula; Atlantic Sector/East Pacific Sector) adults suggested to migrate offshore to spawn, followed by onshore migration to overwinter. Undergo vertical migrations and forays to deeper waters.  **Food web links, energy flows and production:** Links low, mid and high trophic levels from microbes to whales, and supports large and diverse populations of predators. A major metazoan grazer of phytoplankton. Also consumes heterotrophic microplankton, sea ice biota, phytodetritus, and zooplankton (microzooplankton, copepods). Preyed upon by mesopelagic fish (including commercially fished species), squid, sea birds (e.g., penguins, albatross), and marine mammals (seals and baleen whales). Changes in krill distribution and biomass can exert strong bottom-up control on krill-dependant predators and secondary producers  **Biogeochemical cycling:** High biomass suggests potentially important but poorly quantified role (of adults and larvae) in biogeochemical cycling. Intense feeding and egestion, sinking of faecal pellets and moulted exoskeletons suggest high contribution to carbon flux and sequestration. Phytoplankton-krill-whale food chain also contributes to iron cycling in surface waters. Potential but largely unknown role in the cycling of other macronutrients  **Fisheries:** Target species of the largest Southern Ocean fishery (primarily in the southwest Atlantic; Atlantic Sector). Indirectly supports fisheries for mackerel icefish (*Champsocephalus gunnari*) and Patagonian toothfish (*Dissostichus eleginoides*)  **Tourism:** Underpins wildlife tourism | Siegel (1987), Siegel and Watkins (2016), Tarling et al. (2016a), Reiss et al. (2017)  Mackintosh (1973), Nicol et al. (2000a), Hofmann and Murphy (2004); Murphy et al. (2007a), Thorpe et al. (2007), Atkinson et al. (2008); Jarvis et al. (2010), Young et al. (2014), Siegel and Watkins (2016), Silk et al. (2016), Davis et al. (2017), Atkinson et al., (2019), Pinkerton et al. (2020), Yang et al. (2020)  Siegel (1988), Trathan et al. (1993), Murphy et al. (2004a, b), Tarling et al. (2006), Thorpe et al. (2007), Atkinson et al. (2008), Tarling et al. (2009), Piñones and Fedorov (2016), Siegel and Watkins (2016), Meyer et al. (2017), Murphy et al. (2017), Reiss et al. (2017), Perry et al. (2019), Thorpe et al. (2019), Meyer et al. (2020)  Croxall et al. 1999, Pakhomov, (2000), Whitehouse (2008), Schmidt et al. (2011), Hill et al. (2012), Waluda et al. (2012), Schmidt (2014, 2018), Trathan and Hill (2016)  Atkinson et al. (2001), Whitehouse et al. (2008), Schmidt et al. (2011), Atkinson et al. (2012), Hill et al. (2012), Belcher et al. (2019), Cavan et al. (2019), Manno et al. (2020)  CCAMLR (2020) |
| **A picture containing shape  Description automatically generatedOther euphausiids** | **Size range:** Max length ~40 mm (*E. crystallorophias*),  ~42 mm (*T. macrura*)  **Larval stage duration:** ~8 mo  *E. crystallorophias* and *T. macrura*  **Life span:**  4-5 yrs  (*E. crystallorophias*), <4 yrs (*T. macrura*)  **Age at maturity:** Males 2 yrs, Females 2 yrs | **Abundance/biomass:** *E. crystallorophias-* limited data, total biomass potentially orders of magnitude lower than *E. superba*. In some regions, mass per unit area similar in magnitude to those reported for *E. superba*. *T. macrura* - biomass unknown but likely the most numerically abundant euphausiid species, and in some areas is >*E. superba.* No production estimates available  **General distribution:** Patterns of occurrence of *E. crystallorophias* and *E. triacantha* generally defined by latitudinal and bathymetric features**.** *E. crystallorophias* predominantly inhabit coastal areas of the high Antarctic (Antarctic Zone) with greatest densities at ~70°S, common around coastal areas of the east Antarctic (Central Indian and East Indian Sectors) and in the Weddell (7), Amundsen (11) and Ross Seas (12). *T. macrura* is cosmopolitan and ubiquitous and abundant throughout its range: pelagic and coastal, wide latitudinal distribution (Antarctic to Northern Zone).  **Habitat preference:** *E. crystallorophias* replaces *E. superba* in shallow (<500 m) neritic environments covered by sea ice or in open water areas (e.g., polynyas). Narrow thermal habitat of ≤2oC. Reproduction and population dynamics tied to seasonal coastal sea-ice conditions, including the opening of polynyas. Larvae associated with sea ice (occurring shallower or deeper than *E. superba*) and abundant in inshore waters (where they develop over summer and winter, recruiting as juveniles in the spring). Undergoes diel migrations from deep waters during the day to shallow water during the night, that may deepen in the winter or in presence of krill predators). Diel migrations may deepen in winter or in the presence of krill predators. *T. macrura* occupies waters from 0->400 m,wide thermal habitat of -1.8-10oC. Spawning independent of spring bloom. Often found at deeper median depths than *E. superba*. Forms less dense and more spatially distributed aggregations during winter than *E. superba*  **Food web links, energy flows and production:** Both species link low, mid and high trophic levels from microbes to whales (also see McCormack et al., this volume). *E. crystallorophias* important in high latitude food webs where it consumes sea ice biota, phytoplankton (incl. phytodetritus) and zooplankton. Preyed upon by mesopelagic fish, squid, sea birds (e.g., penguins, albatross) and marine mammals (seals and baleen whales). *T. macrura* important in lower latitude food webs. More predatory than *E. superba* consuming zooplankton (microzooplankton, copepods and *E. superba* larvae), sea ice algae and phytoplankton. Preyed upon by mesopelagic and bentho-pelagic fish, seabirds and marine mammals (seals and baleen whales)  **Biogeochemical cycling:** Abundance suggest potentially important but poorly quantified roles in carbon cycling and sequestration (particularly in regions where numerical abundance is high). Potential but poorly known role in iron (via feeding on diatoms) and macronutrient cycling  **Fisheries:** *E. crystallorophias* occurs as a bycatch in the *E. superba* fishery  **Tourism:** Contributes to wildlife tourism | Siegel (1987), Boysen-Ennen (1991), Nordhausen (1992), Kirkwood (1996), Pakhomov and Persissinotto (1996), Siegel (2000), Sala et al. (2002), Haraldsson and Siegel (2014), Driscoll et al. (2015), La et al. (2015), Loeb and Santora (2015), Steinberg et al. (2015), Wallis et al. (2020)  Mauchline and Fisher (1969), Boysen-Ennen and Piatkowski (1988), Boysen-Ennen et al. (1991), Sala et al. (2002), Murase et al. (2006), Loeb et al. (2009), McLeod et al. (2010), Couzin-Roudy et al. (2014), Ainley et al. (2015), La et al. (2015), Piñones et al. (2016), Davis et al. (2017), Pinkerton et al. (2020), Yang et al. (2020)  Hempel and Marschoff (1980), Hagen and Kattner (1998),Thomas and Green (1988), Lancraft et al. (1989), Nordhausen (1994), Pakhomov and Perissinotto (1996), Pakhomov (1997), Marrari et al. (2001), Ainley et al. (2004), Daly and Zimmerman (2004), Taki and Hayashi (2005) Taki et al. (2008), Ono et al. (2011), Weibe et al. (2011), Haraldsson and Siegel (2014), Ainley et al. (2015), Loeb and Santora (2015), Wallis (2018), Driscoll (2019), Conroy et al. (2020), Liszka et al. (2021)  Hopkins (1985), O’Brien (1987), Thomas and Green (1988), Hopkins and Torres (1989), Pakhomov and MQuaid (1996), Pakhomov and Perissinotto (1996), Pakhomov (1997), Hagan and Kattner (1998), Ainley et al. (2004), Diebel and Daly (2007), Driscoll (2019), Kohlbach et al. (2019)  Guglielmo et al. (2009), Kohlbach et al. (2019)  CCAMLR (2020) |
| **A picture containing sitting, light  Description automatically generatedCopepods** | **Size range:** ~1 mm(*Oithona similis*)*–*10 mm (*Rhincalanus gigas*)  **Larval stage duration:**  Weeks-months  **Life span:** max 2 yrs  **Age at maturity:**  2-18 mo | **Abundance/biomass:** Total biomass (dominated by large *Calanoides*, *Calanus, Rhincalanus* and *Metridia* spp.) is at least *E. superba*, total production > *E. superba.* Smaller copepods (e.g., *Oithona similis,* *Ctenocalanus citer*, *Microcalanus pygmaeus* and *Stephos longipes*) are numerically dominant  **General distribution:** Typically circumpolar, similar to other zooplankton groups. Characterised by large variations in horizontal and vertical and distribution patterns. Information limited in some localities and seasons due to sampling difficulties. Vertical distribution of the group is throughout the whole water column  **Habitat preference:** Copepods exhibit a diverse range of life history strategies and habitats. Thermal habitats defined in part by circumpolar fronts. *Calanoides, Calanus, Rhincalanus* and *Metridia* perform varying degrees of seasonal vertical migration between summer feeding grounds in the epipelagic zone and overwintering depths >200 m in deep water (up to 1000 m in the case of e.g., *C. acutu*s), but remain active in near surface waters in coastal systems. Smaller copepod species undertake seasonal migrations (e.g., *Ctenocalanus citer*) and/or are dependent on sea ice (e.g., *Drescheriella,* *Paralabidocera* and *Stephos*)  **Food web links, energy flows and production**: Link low, mid and high trophic levels from microplankton to whales. Consume a wide variety of prey (detritus, heterotrophic microplankton, phytoplankton, and zooplankton) due to large diversity in body size and feeding modes across the taxa and ontogenetic stages. Potentially more important consumers of primary producers than *E. superba* (due to higher mass-specific ingestion rates). Intraguild predation occurs in large predatory species (e.g., *Paraeuchaeta antarctica*) and may be important for other copepods. Preyed upon primarily by zooplankton (incl. chaetognaths, amphipods, euphausiids, and cnidarians) and by myctophid fish (particularly on larger copepod species), seabirds (particularly small petrels) and whales. Some *E. superba-*dependent higher trophic level predators may also switch to consuming copepods (and/or alternative prey sources) during short-term fluctuations in krill abundance/availability  **Biogeochemical cycling:** High abundance/biomass and ingestion rates (higher than *E. superba*) suggest potentially important but poorly quantified roles in carbon cycling and sequestration. Feeding on phytoplankton (diatoms) also contributes to iron and macronutrient cycling  **Fisheries:** Indirectly supports *E. superba* fishery (as prey for *E. superba*)  **Tourism:** Contributes indirectly to wildlife tourism | Conover and Huntley (1991), Voronina (1998), Shreeve et al. (2005)  Ommanney (1936), Andrews (1966), Voronina (1972), Atkinson (1998), Pakhomov and Froneman (2000), Hosie et al. (2003), Ward et al. (2007, 2008, 2012, 2018), McLeod et al. (2010), Pinkerton et al. (2010, 2020), Swadling et al. (2010), Takahashi et al. (2011)  Schnack-Schiel and Mizdalski (1994), Schnack-Schiel et al. (1995), Tanimura et al. (1996), Swadling et al. (2004), Cornils et al. (2017)  Hopkins (1985), Hopkins and Torres (1989), Hill et al. (2012), Saunders et al. (2019)  Hill et al. (2012) |
| **Salps**  A picture containing icon  Description automatically generated | **Size range:** 20-40 mm, max 160 mm  **Life stages:** Alternate between sexually reproducing blastozooids, and asexually reproducing oozoids.  **Life span:** 3 mo-1-2 yrs  **Age or length at maturity:** Blastozooids 20-25 mm, oozoids 45-55 mm | **Abundance/biomass:** Major contributors to total wet biomass, and third in terms of dry or carbon mass, of euphausiids, salps and copepods. No annual production estimates available. *S. thompsoni* has highest salp biomass. Can undergo rapid localised population increases (blooms)  **General distribution:** Seven salp species occur south of the Subtropical Front, only *Salpa thompsoni* and *Ihlea racovitzai* occur south of the Antarctic Polar Front. *I. racovitzai* occurs closer to the continent.  *S. thompsoni* cannot establish persistent populations in the high Antarctic and its occurrence there is likely sustained by advection of warm waters. Characterized by high patchiness from the small to large spatial scales  **Habitat preference:** *S. thompsoni* found over a range of habitats. Has a broad thermal range (-1.5-9oC) but primarily occurs in warmer waters (2-5oC). *I. racovitzai* found in cold, ice-covered regions (closer to the continent). Both species show little overlap in habitat with *E. superba* across large scales (i.e., >mesoscales). Active vertical migrators between surface layer and 300-500 m  **Food web links, energy flows and production**: Link low, mid and high trophic levels from microplankton to seabirds (see also McCormack et al., this volume). Non-selective consumers of a wide range of prey sizes (small flagellates and phytoplankton, with a preference for picoplankton). *S. thompsoni* preyed upon by zooplankton (incl. *E. superba*), demersal and mesopelagic fish (including commercially fished *Dissostichus eleginoides*) and seabirds. *I. racovitzai* predators unknown  **Biogeochemical cycling:** High biomass and ingestion rates (highest of any primary consumer in Antarctic pelagic community) suggest potentially important but poorly quantified roles in biogeochemical cycling. Sinking of salp carcasses and faecal pellets suggest high but spatially variable contribution to carbon flux and sequestration. However, recycling of salp faecal pellets in the epipelagic layer may also be important. Feeding on phytoplankton (diatoms) also contributes to iron cycling in surface waters. Potential but unknown role in the cycling of other macronutrients  **Fisheries:** Occurs as bycatch in the *E. superba* fishery | Foxton (1961, 1966), Voronina (1998), Pakhomov et al. (2002), Loeb and Santora (2012), Pakhomov and Hunt (2017), Henschke et al. (2018), Groeneveld et al. (2020)  Foxton (1966), Pakhomov et al. (2002)  Foxton (1966), Loeb et al. (1997), Nicol et al. (2000b), Pakhomov et al. (2002), Henschke and Pakhomov (2019)  Perissinotto and Pakhomov (1998), Pakhomov et al. (2002), Gili et al. (2006), von Harbou et al. (2011), Jarman et al. (2013), Pakhomov et al. (2019)  Bruland and Silver (1981), Perissinotto and Pakhomov (1998a, b), Pakhomov et al. (2002), Pakhomov (2004), Pakhomov and Froneman (2004), Atkinson et al. (2012), Bernard et al. (2012), Alcaraz et al. (2014), Manno et al. (2015), Henschke et al. (2016), Maldonado et al. (2016), Cabanes et al. (2017), Iversen et al. (2017)  CCAMLR (2020) |
| **Pteropods**  A picture containing arrow  Description automatically generated | **Size range:** 1-5 mm (*Limacina* spp.),  10-20 mm (*Clio spp.* and gymnosomes)  **Larval stage duration:** 2-6 mo  **Life span:** >1yr  **Age at maturity:** 6 mo | **Abundance/biomass:** Total biomass/abundance unknown. Globally, the highest average pteropod biomass is estimated to occur in the Southern Ocean. Contribution to zooplankton abundance varies spatio-temporally. Densities >1000 ind.m-3 recorded in some locations  **General distribution:** Six pteropod species (shelled, thecosomes: *Limacina helicina antarctica*, *L. retroversa australis*, *Clio pyramidata*, *C. piatkowskii*, and shell-less gymnosomes: *Spongiobranchaea australis* and *Clione limacina antarctica*) occur throughout waters of the Antarctic and Subantarctic Zones, with species composition differing north and south of the Antarctic Polar Front. Highest average biomass estimated between 70-80°S. All predominantly epipelagic, *C. piatkowskii* mesopelagic  **Habitat preference:** Species compositions either side of the Antarctic Polar Front reflect temperature tolerances, with *L. retroversa australis* dominating to the north and *L. helicina antarctica* to the south.Hotspots recorded around all islands (particularly South Georgia, SG), Ross Sea (12) and the Antarctic Polar Front. Undergo diel and seasonal migrations, with most species occurring deeper (to 1000 m) during winter. Gymnosome abundance tracks thecosome abundance, reflecting their trophic dependency. Pteropod abundances are also positively correlated with primary production  **Food web links, energy flows and production**: Link low to mid trophic levels from phytoplankton to fish (see also McCormack et al., this volume). Gymnosomes are specialist predators on thecosomes, and also consume phytoplankton (including diatoms) and microzooplankton (dinoflagellates, tintinnids, copepod nauplii). Thecosomes are predominantly herbivorous (on phytoplankton) and can also feed on detritus. Pteropods are preyed upon by zooplankton and myctophid fish  **Biogeochemical cycling:** High ingestion rates (among the highest zooplankton rates) and community grazing pressure (particularly by *C. pyramidata*) suggest they play an important but unquantified role in biogeochemical cycling. Contribute to the direct export of carbon and sequestration to the deep ocean via sinking of dead individuals (ballasted by their shells), mucous flocs, and faecal pellets. Their calcification also contributes to the carbonate counter pump which releases CO2 back into surface waters. Thecosomes produce (relatively soluble) aragonite shells and are thus sensitive to ocean acidification | Pane et al. (2004), Hunt et al. (2008), Steinberg et al. (2015), Hunt et al. (2016)  Hunt et al. (2008), van der Spoel et al. (1999), Hunt et al. (2018), Bednaršek et al. (2012a), Akiha et al. (2017), Steinberg et al. (2015), Pinkerton et al. (2020)  Van der Spoel et al. (1999), Seibel and Dierssen (2003), Hunt et al. (2008), McLeod et al. (2010), Flores et al. (2014), Steinberg et al. (2015), Pinkerton et al. (2020)  Hunt et al. (2008)  Mucci (1993), Fabry et al. (2008), Manno et al. (2010, 2017, 2018, 2020), Bednaršek et al. (2017a, 2019) |

\*See main paper for full reference details